Headquarters U.S. Air Force

Integrity - Service - Excellence

FORMER WILLIAMS AFB
ST012 SITE
STEAM ENHANCED EXTRACTION

BCT UPDATE

15 JANUARY 2015

Headquarters U.S. Air Force

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SITE ST012,
FORMER LIQUID FUELS STORAGE AREA

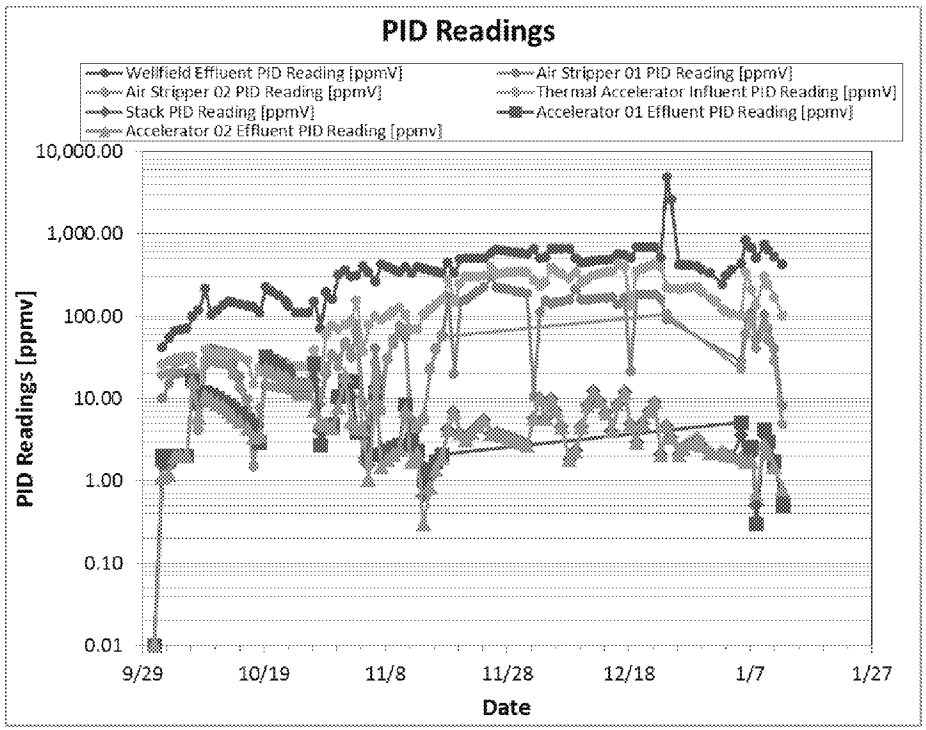
REMEDIAL ACTION

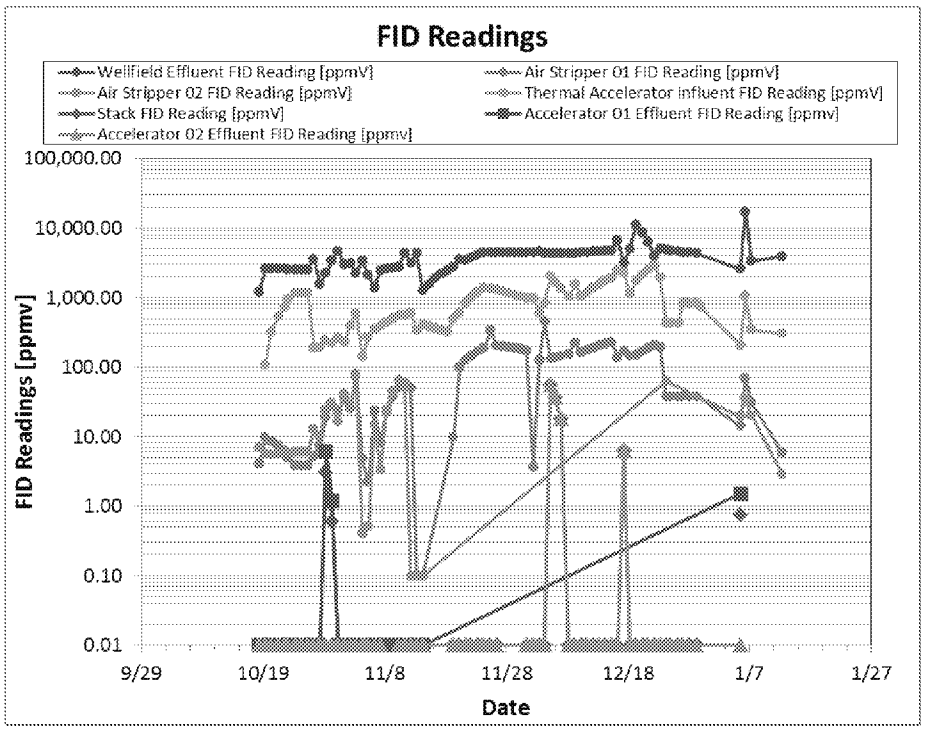
SEE System Updates

ST012 SEE SYSTEM STATUS - SUMMARY

	Value	Unit
Target Treatment Zone (TTZ) Soil Volume	410,000	cubic yards (cy)
Area	199,000	square feet (ft^2)
Upper Depth of Treatment	145	feet (ft) below ground surface (bgs)
Lower Depth of Treatment	245	ft bgs
Vapor Liquid Treatment Started	09/29/14	
Thermal Operations Started	09/29/14	
Last Process Data Update	01/12/15	
Last Temperature Data Update	01/12/15	
Estimated Total Days of Operation	422	days
Days of Operation	105	days
Days of Operation vs. Estimate	25	percent (%)
Estimated Total Energy Usage	11,343,000	kilowatt hours (kWh)
Total Energy Used	830,980	kWh
Used Electrical Energy vs. Estimate	7	%
Total Steam Injected	53.4	million pounds (lbs)
Projected Total Steam Injection	320	million lbs
Steam Injected Vs Projected	17	%
Mass Removed in Vapor Based on Photoionization Detector (PID) Readings	93,420	lbs
Mass Removed as NAPL	46,283	lbs
Total Vapor and Liquid Mass Removal (based on PID readings)	139,704	lbs
Average Power Usage Rate Last Week	328	kilowatts (kW)
Average Wellfield Vapor Extraction Rate Last Week	230	standard cubic feet per minute (scfm)
Average Condensate Production Rate Last Week	0	gallons per minute (gpm)
Average Water Extraction Rate Last Week	79	gpm
Total Water Extracted	14,335,221	gallons
Recovered Light Non-Aqueous Phase Liquid (LNAPL)	7,034	gallons
Average Water Discharge Rate Last Week	112	gpm
Total Treated Water Discharge	17,807,000	gallons

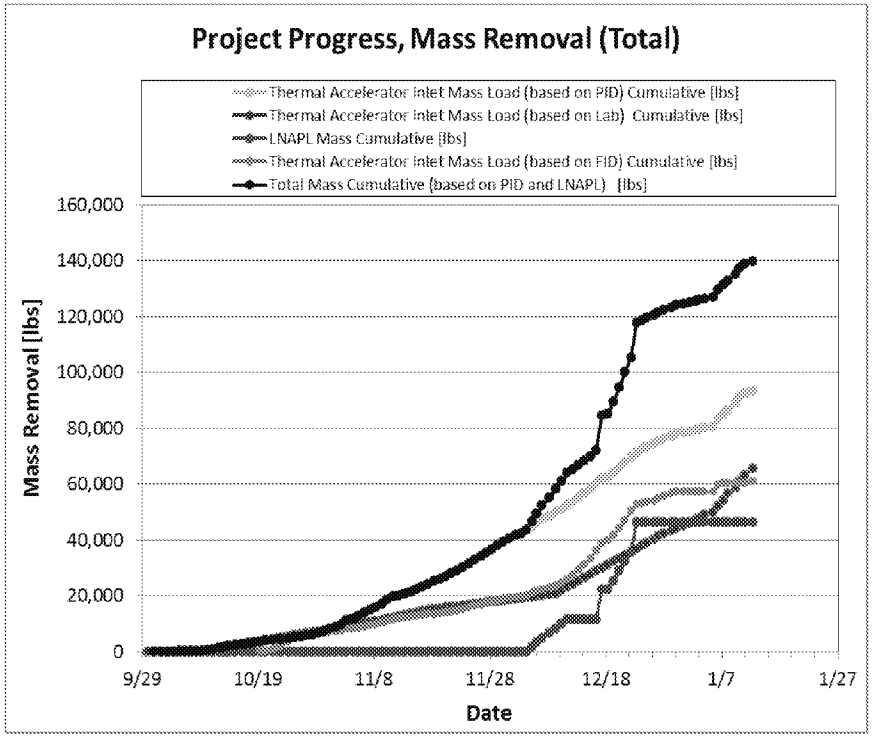
ST012 SEE SYSTEM PID/FID READINGS

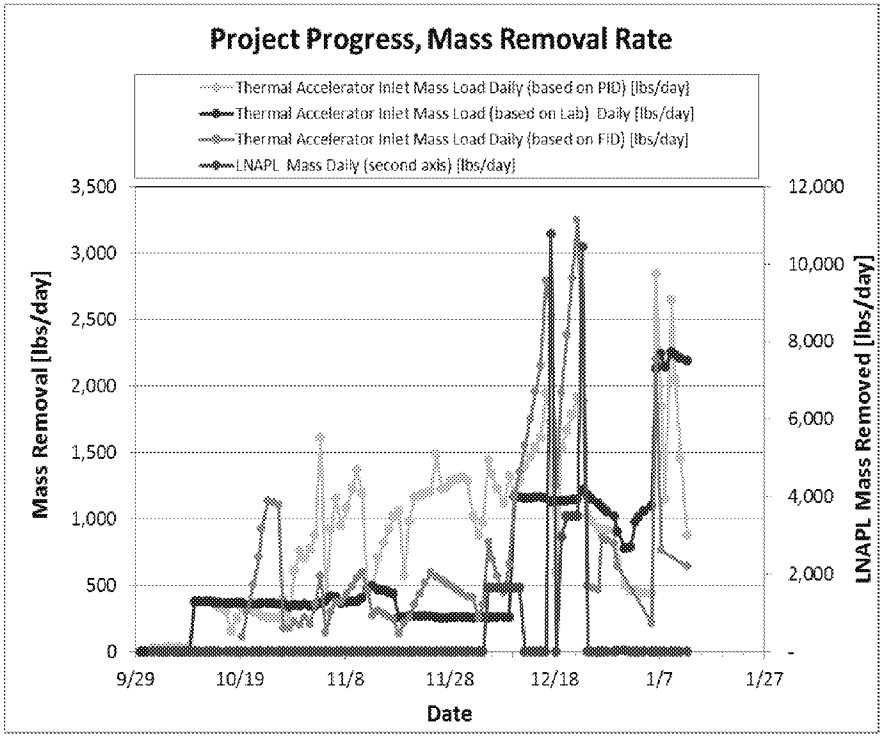




- Vapors continue to be rich in organics

ST012 SEE SYSTEM MASS REMOVAL





- **NAPL recovery began in early December and is beginning to ramp up again after the liquid extraction system shut down (12/23-1/4)**

ST012 Steam Injection Status

ST012 SEE OPERATIONAL PROGRESS

- **SEE Startup** — 29 Sep
- **Extraction Only Phase** — 29 Sep – 15 Oct
  - All CZ, UWBZ, and LSZ MPE wells turned on
  - Extraction System Optimization/Troubleshooting
  - Perimeter Monitoring to Demonstrate Hydraulic Control
- **Steam Injection Step 1** — 16 Oct – 3 Nov
  - 9 Exterior LSZ wells
  - Perimeter and Temperature Monitoring for Effects
- **Steam Injection Step 2** — 3 Nov – 4 Dec
  - Same 9 Exterior LSZ wells from Step 1
  - Add 6 Interior LSZ wells
  - Perimeter and Temperature Monitoring for Effects
- **Steam Injection Step 3 – revised** — 4 Dec – 22 Dec
  - Same 15 LSZ wells from Step 2
  - Add 7 Exterior UWBZ wells
  - Perimeter and Temperature Monitoring for Effects

ST012 SEE OPERATIONAL PROGRESS - CONTINUED

- **December 21**
  - Operational personnel detected a product layer in Tank T-102.
- **December 22**
  - Operational personnel reduced liquid extraction rates by reverting to the extraction strategy of four eductor skids online, two skids offline to reduce the overall extraction rate from the site (to increase residence time in the liquid treatment system).
- **December 23**
  - Steam injection rates to the LSZ steam injection wells were reduced by approximately 25% to accommodate the reduction in the liquid extraction rates across the site.
  - David Gonzales of the City of Mesa notified operation personnel that he received an email from his wastewater collection crew informing him, "the lift station collecting wastewater downstream from Gateway area including the ST012 site had a very strong odor of petroleum oil and a floating oil layer."
  - Site operations met and decided as a conservative measure to shut down the liquid extraction system until operational modifications could be made.

ST012 SEE OPERATIONAL PROGRESS - CONTINUED

- **December 24**
  - Liquid extraction system restarted utilizing both air strippers, both thermal accelerators and an alternate set of liquid carbon vessels.
  - Due to the increase in PID headspace readings and the loss of function of the FID, the site team decided to shut down the liquid extraction system until previously scheduled cleanout of Tank T-102 and carbon vessel change outs could be performed (performed week of 12/29/14).
  - Vapor extraction and steam injection systems remained operational – steam boiler was placed into "low-fire" to reduce steam injection rates across the site.
  - Site operations continued to monitor temperatures and perimeter water levels during the liquid extraction system shut down and the steam bubble remained stable throughout the shut down period.
  - Steam injection rate was reduced further to an injection rate ~ 130,000 lbs/day corresponding to approximately 15-20% of maximum steam injection capacity.
- **December 29**
  - Tank T-102 cleaned out and product removed.

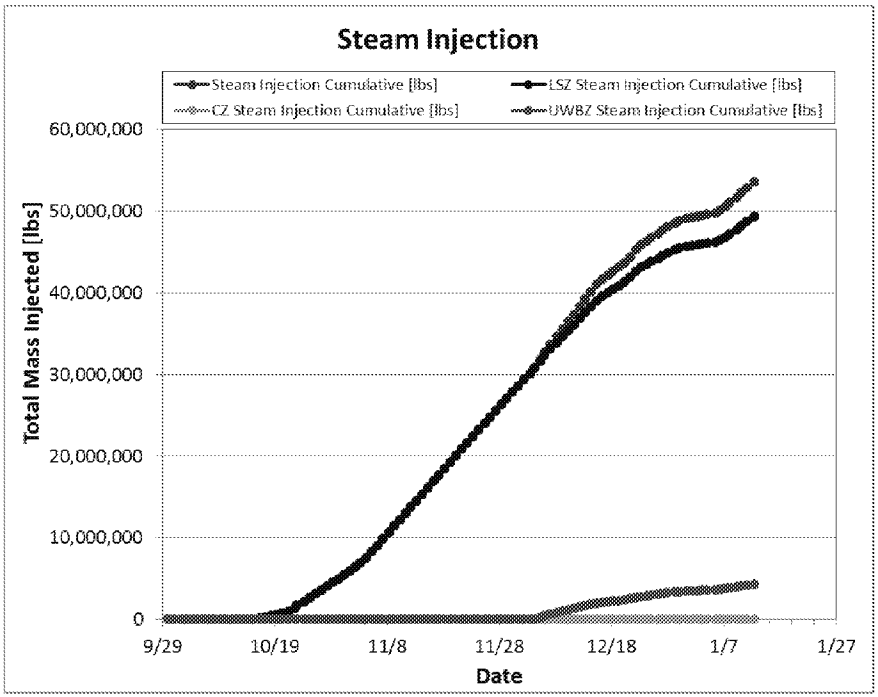
ST012 SEE OPERATIONAL PROGRESS - CONTINUED

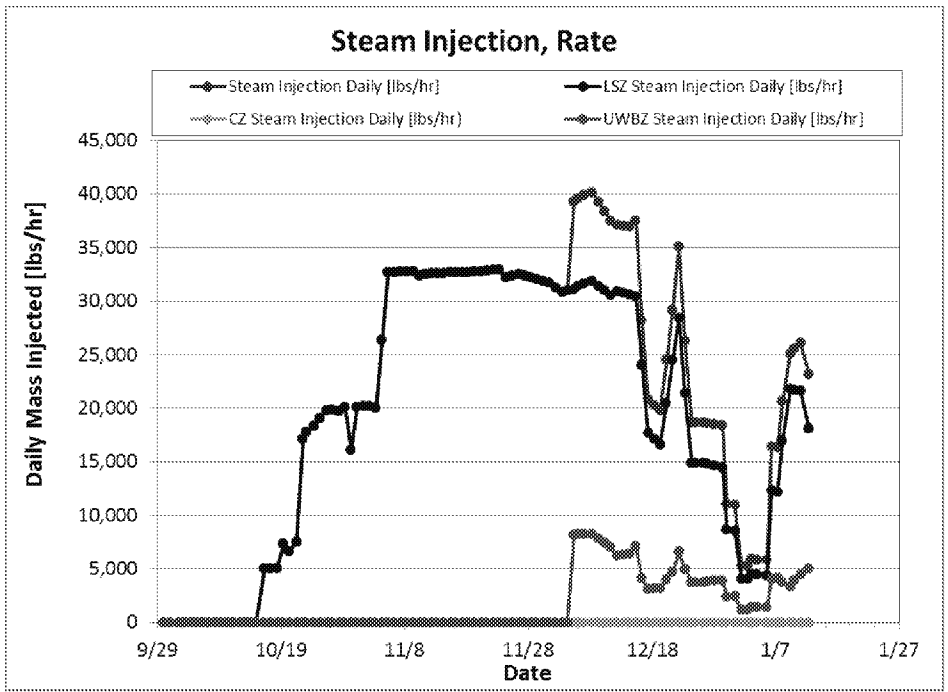
- January 2
  - Liquid carbon vessel change out completed.
- January 5-7
  - Liquid extraction system restarted with a modified extraction strategy utilizing three eductor skids operating at the same time.
  - Liquid treatment system configured with the process stream split through both air strippers.
  - Total flow rate targeted to be ~300 gpm to allow for additional residence time through the liquid treatment system.
  - Extracted a volume at restart approximately equivalent to the steam that was injected during the extraction system shutdown (before increasing steam injection rates again).
- January 8-9
  - Increased LSZ and UWBZ well steam injection rates to near 2,200 and 1,100 lbs/hr (a total of 13 steam injection wells), respectively.
  - Steam injection rates were not increased in nine steam injection wells that surround three MPE wells (CZ 12, LSZ 15 and UWBZ 4) that require maintenance following the shut down period.

ST012 SEE OPERATIONAL PROGRESS - CONTINUED

- **January 12**
  - In response to perimeter groundwater levels collected on January 11, 2015, the steam injection rate in the LSZ wells was reduced to 1,100 lbs/hr in 9 LSZ wells.
- **January 13**
  - Another round of groundwater levels was collected and data indicated a substantial decrease in perimeter groundwater levels.

ST012 SEE STEAM INJECTION





- **Steam injection into UWBZ 5,100 lbs/hr ~ 10 gpm as water, LSZ 22,500 lbs/hr ~ 45 gpm as water total**
  - **Total steam injection rate equivalent to 55 gpm of water**

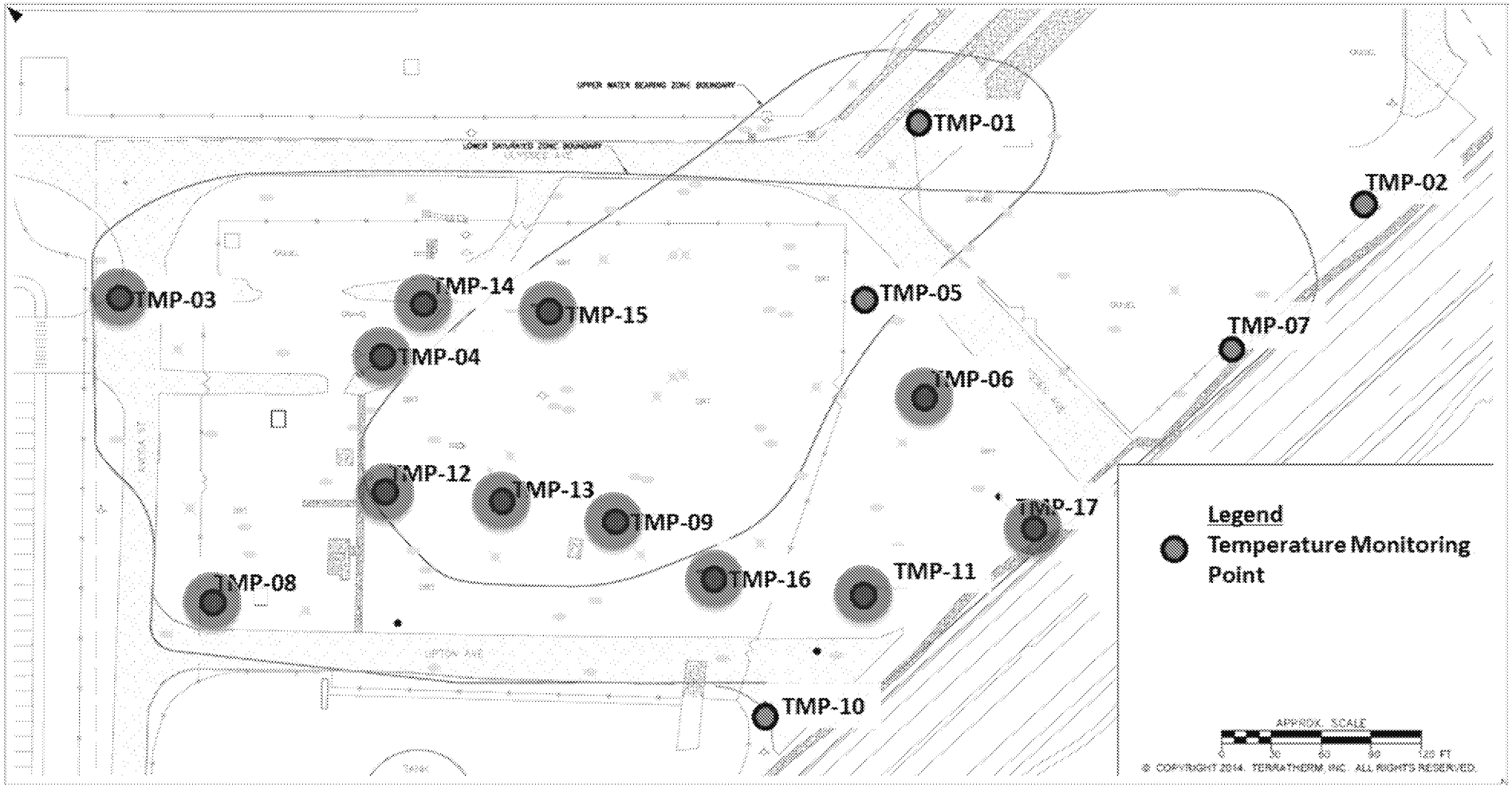
ST012 SEE DISCHARGE COMPLIANCE

Liquid Process Sample Collection:

- **December 22:**
  - **VOCs within permit parameters (in addition GAC effluent concentrations of PCE: 30 ug/L and TCE: 130 ug/L were detected)**
  - **Reviewing sample results related to a detection of beta-BHC on the carbon vessel effluent**
  - **Investigation of carbon source and if regenerated or virgin**
- **January 5:**
  - **VOCs within permit parameters**
- **City of Mesa**
  - **Verbally told that city-collected sample results do not show an exceedance from the ST012 SEE system**
  - **City of Mesa investigation is still ongoing**
  - **Preparation of report to City of Mesa in accordance with permit**

ST012 Steam Injection Influence at Temperature Monitoring Points

ST012 TEMPERATURE MONITORING POINTS



- Highlighted TMPs show heat up

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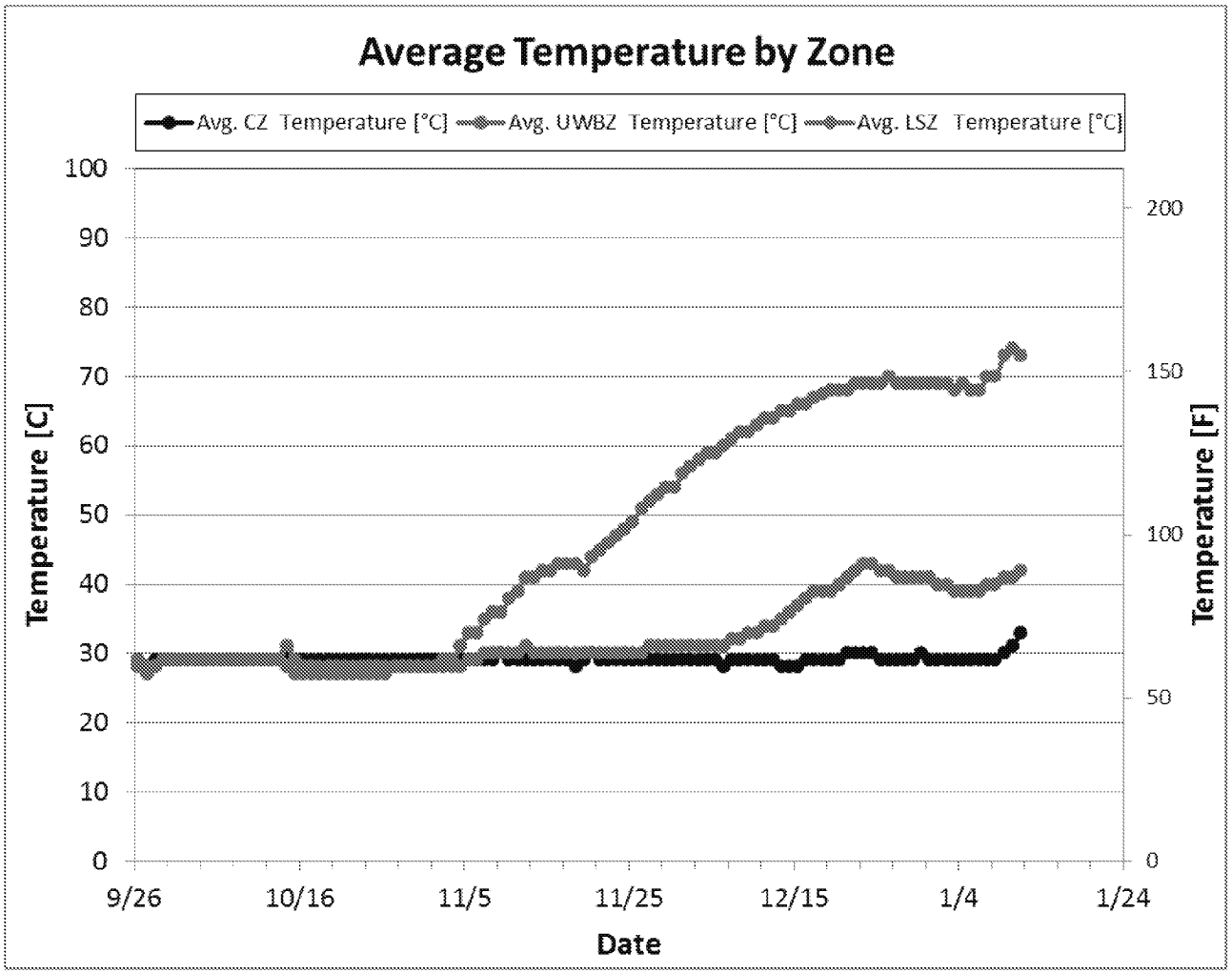
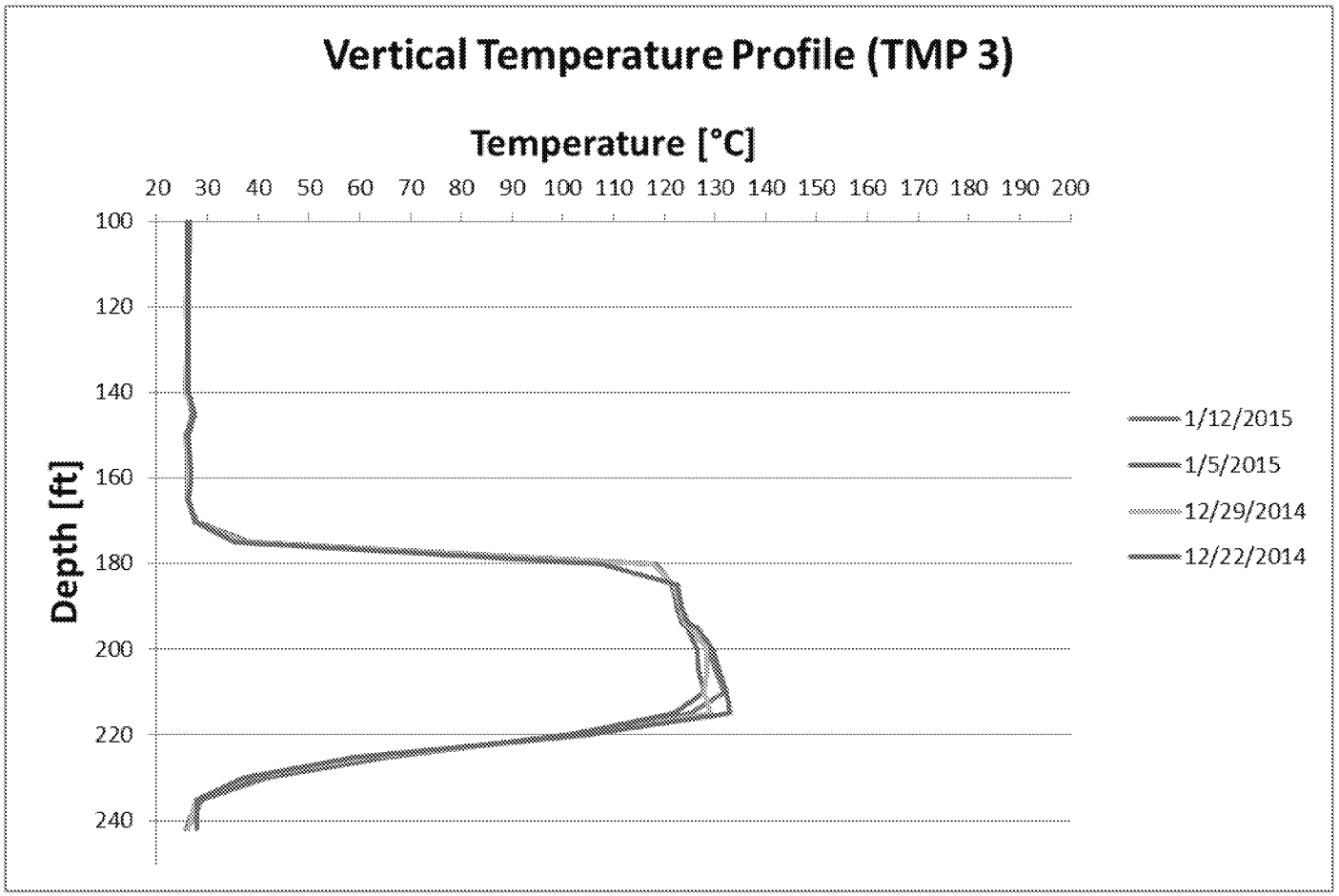
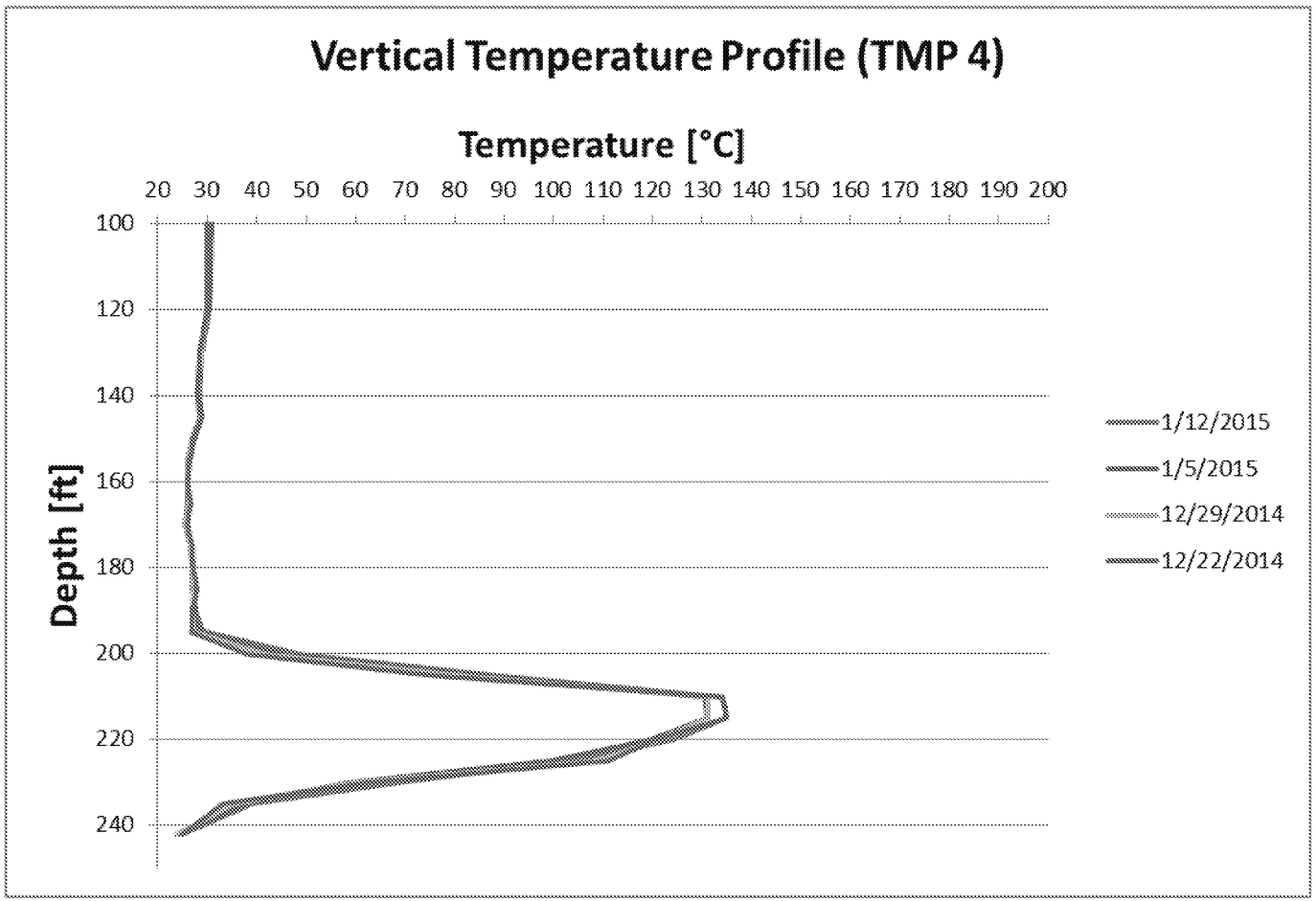
ST012 SEE COLLOCATED TEMPERATURES AT EXTRACTION WELLS BY ZONE




Vertical Temperature Profile (TMP 3)
Temperature [°C]
20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Depth [ft]
100 120 140 160 180 200 220 240
1/12/2015
1/5/2015
12/29/2014
12/22/2014


Vertical Temperature Profile (TMP 4)
Temperature [°C]
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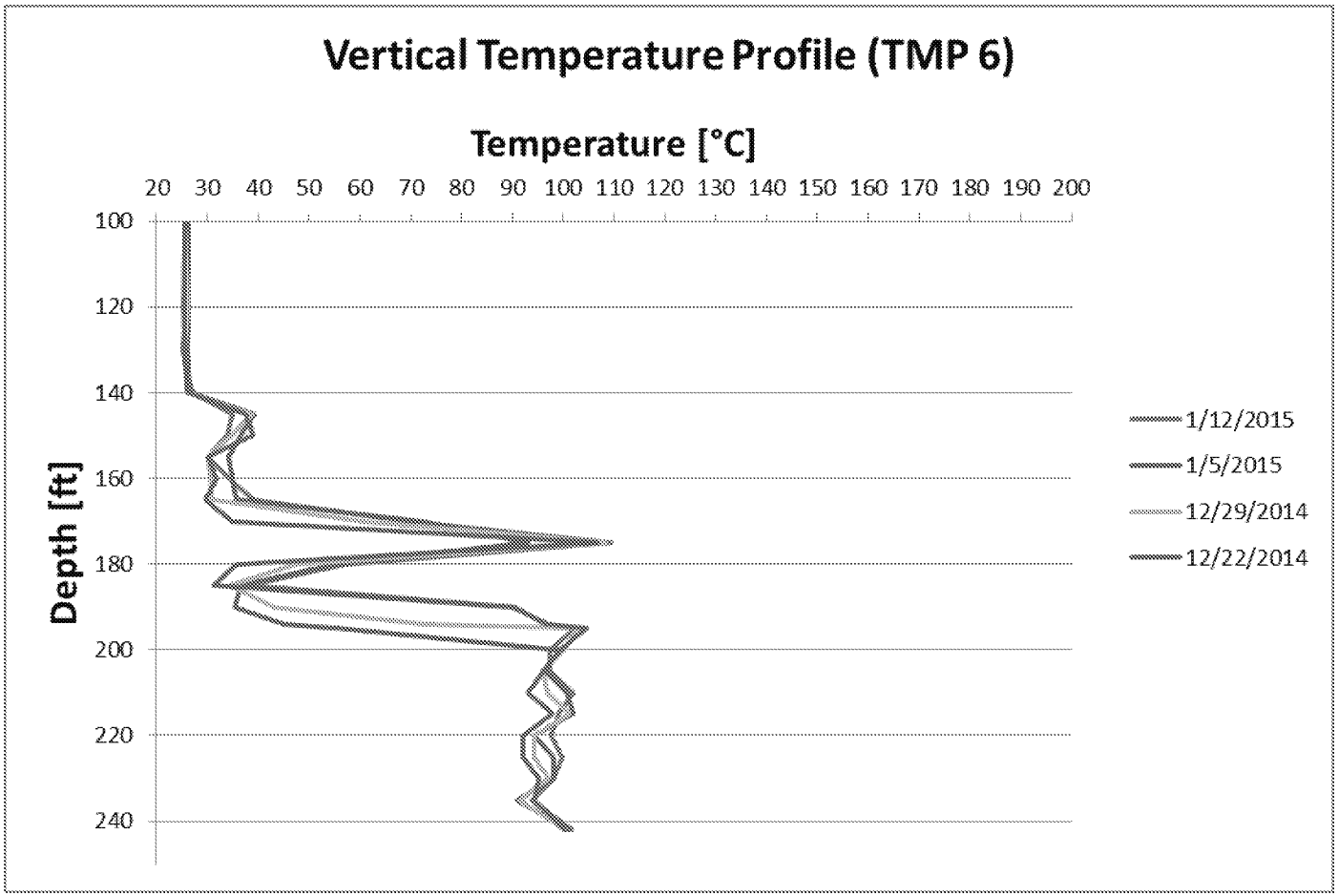
Depth [ft]
100
120
140
160
180
200
220
240
1/12/2015
1/5/2015
12/29/2014
12/22/2014


Vertical Temperature Profile (TMP 6)
Temperature [°C]
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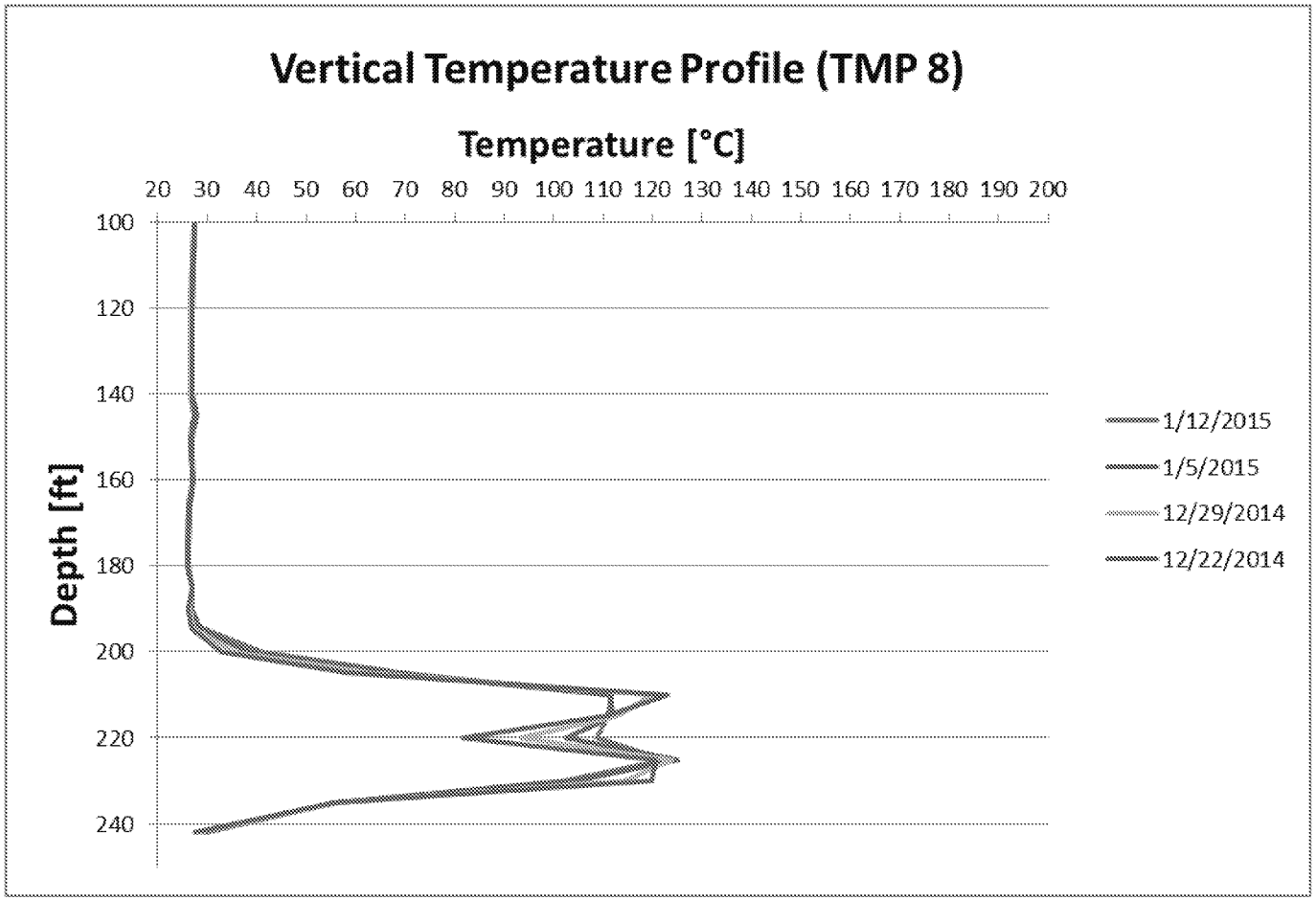
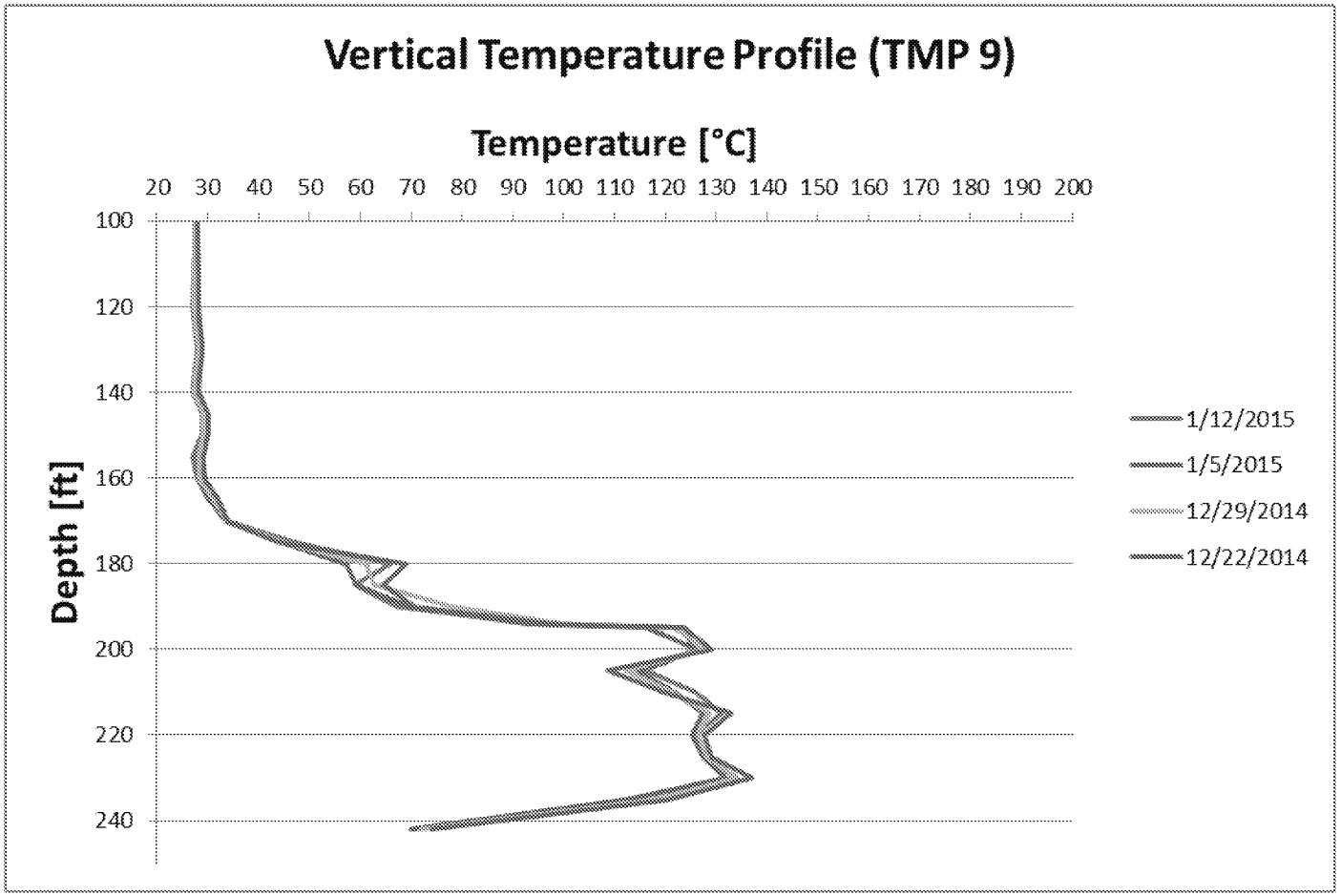
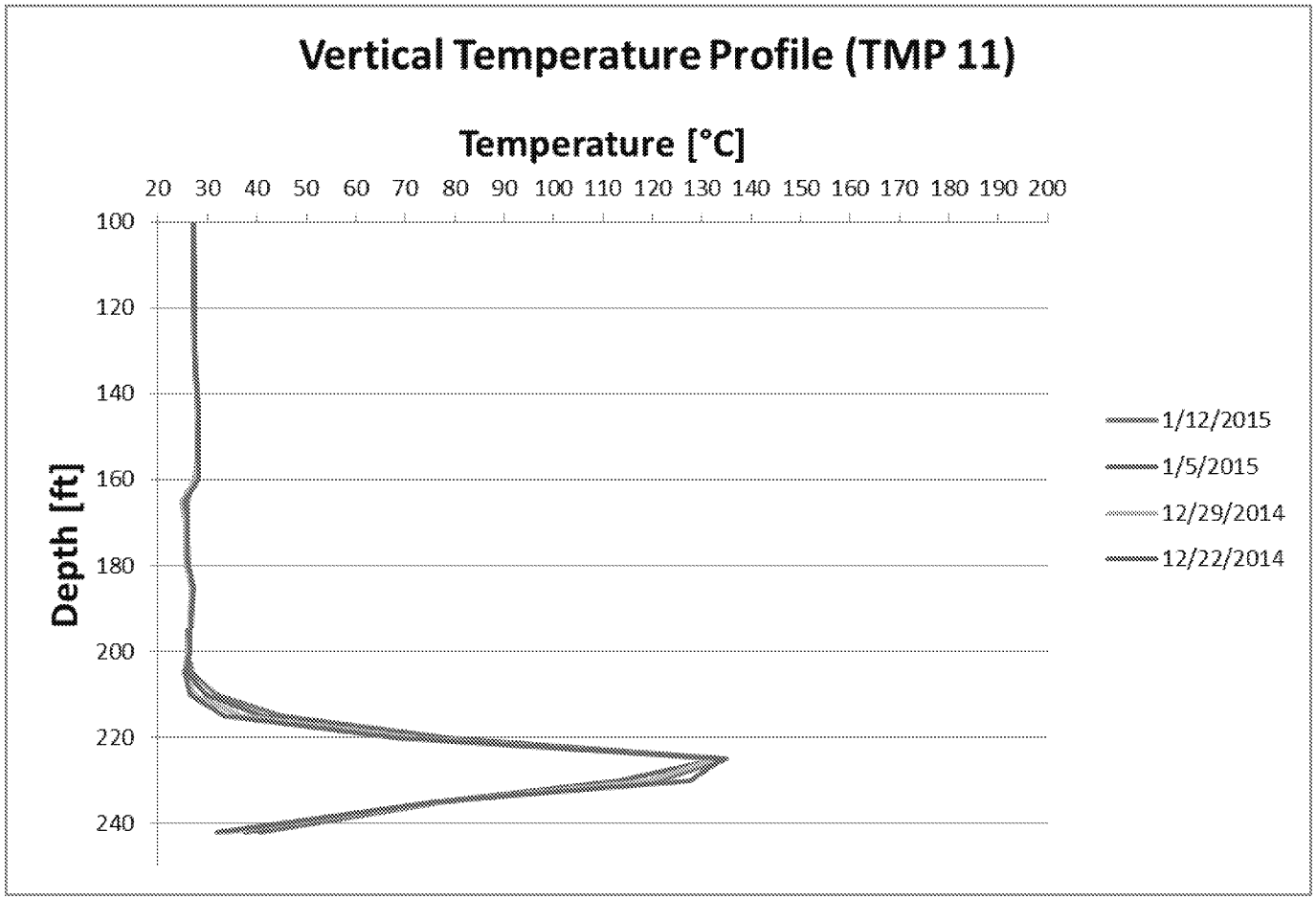
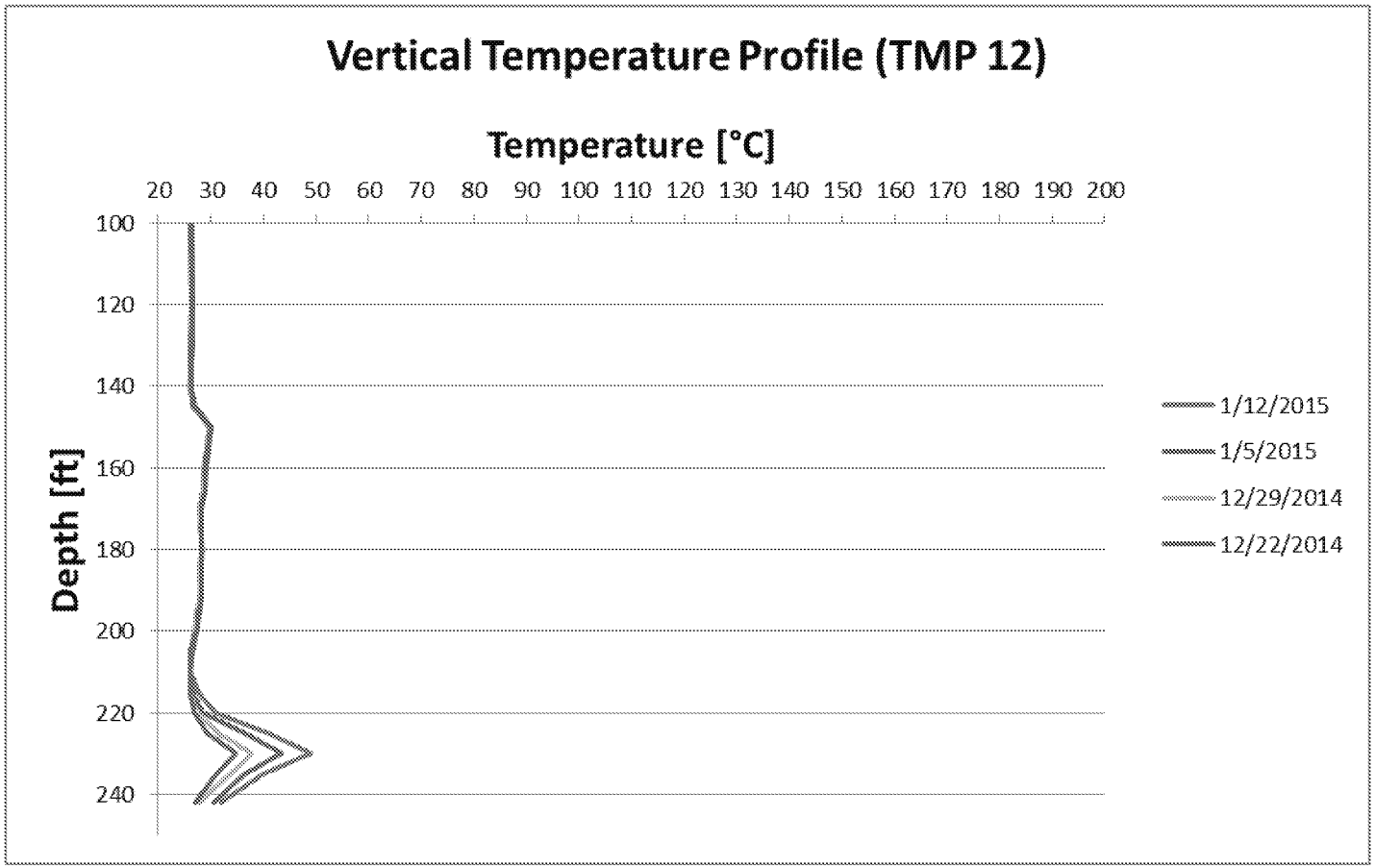
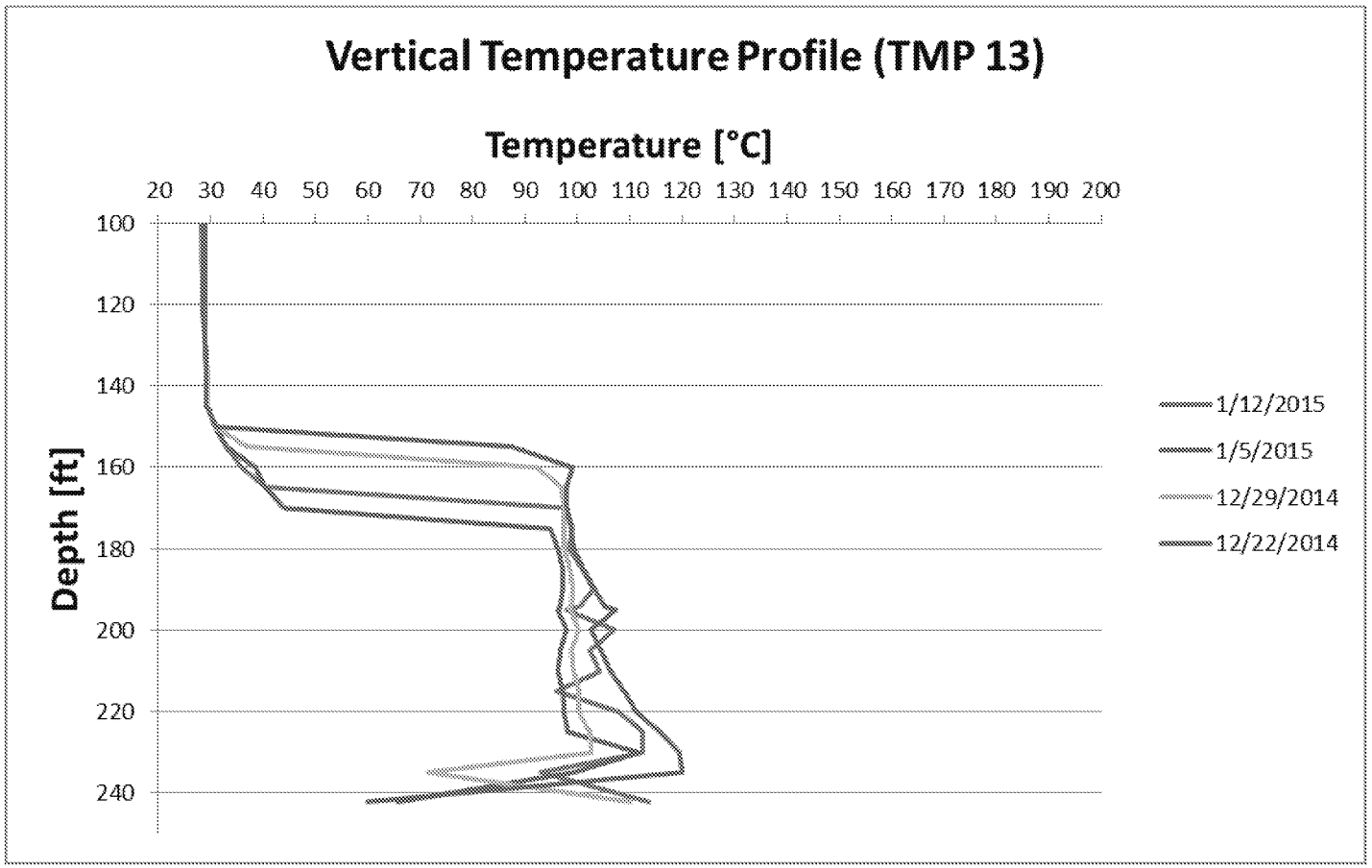
Depth [ft]
100 120 140 160 180 200 220 240
1/12/2015
1/5/2015
12/29/2014
12/22/2014

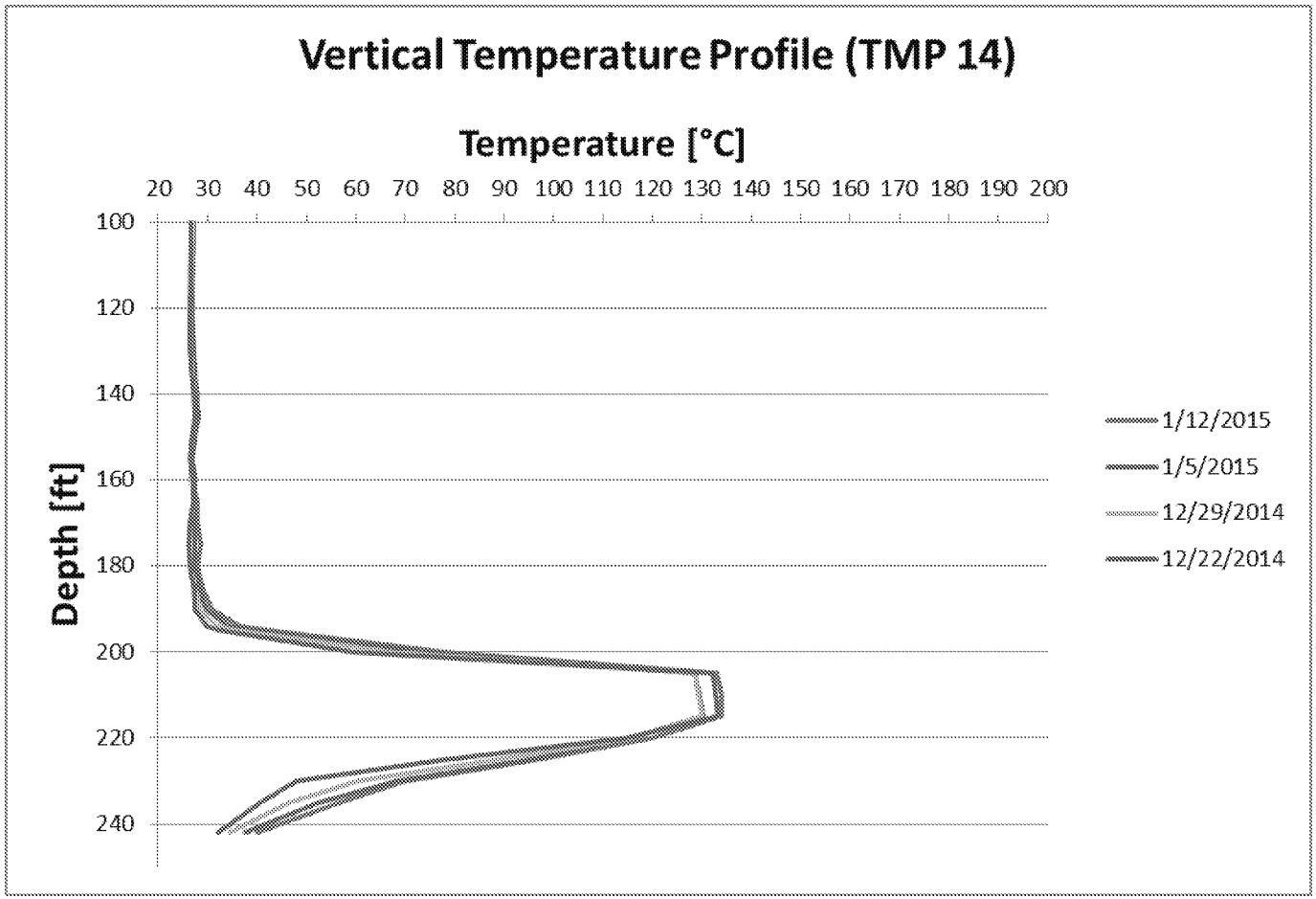

Vertical Temperature Profile (TMP 8)
Temperature [°C]
20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Depth [ft]
100
120
140
160
180
200
220
240
1/12/2015
1/5/2015
12/29/2014
12/22/2014

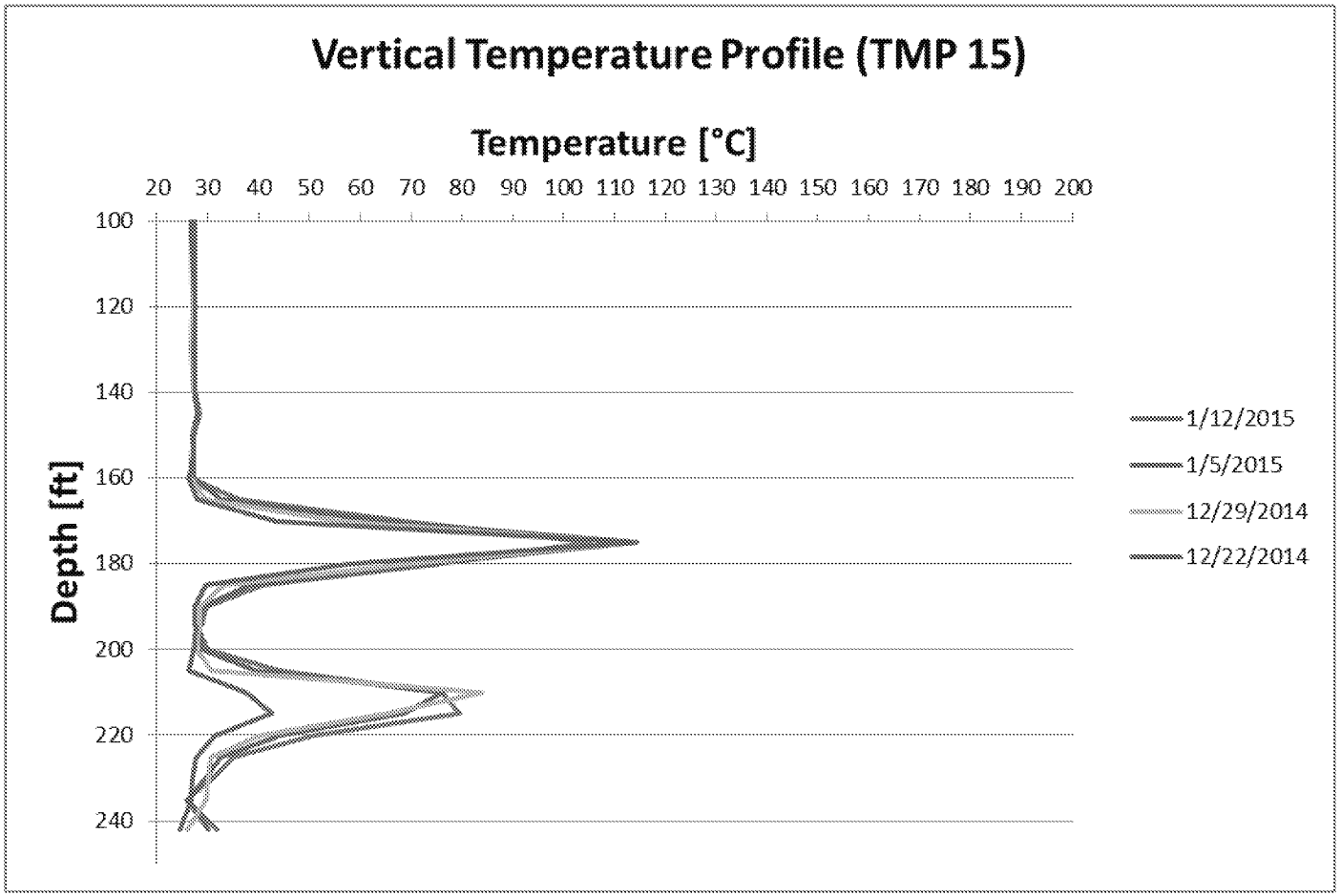

Vertical Temperature Profile (TMP 9)
Temperature [°C]
20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Depth [ft]
100 120 140 160 180 200 220 240
1/12/2015
1/5/2015
12/29/2014
12/22/2014

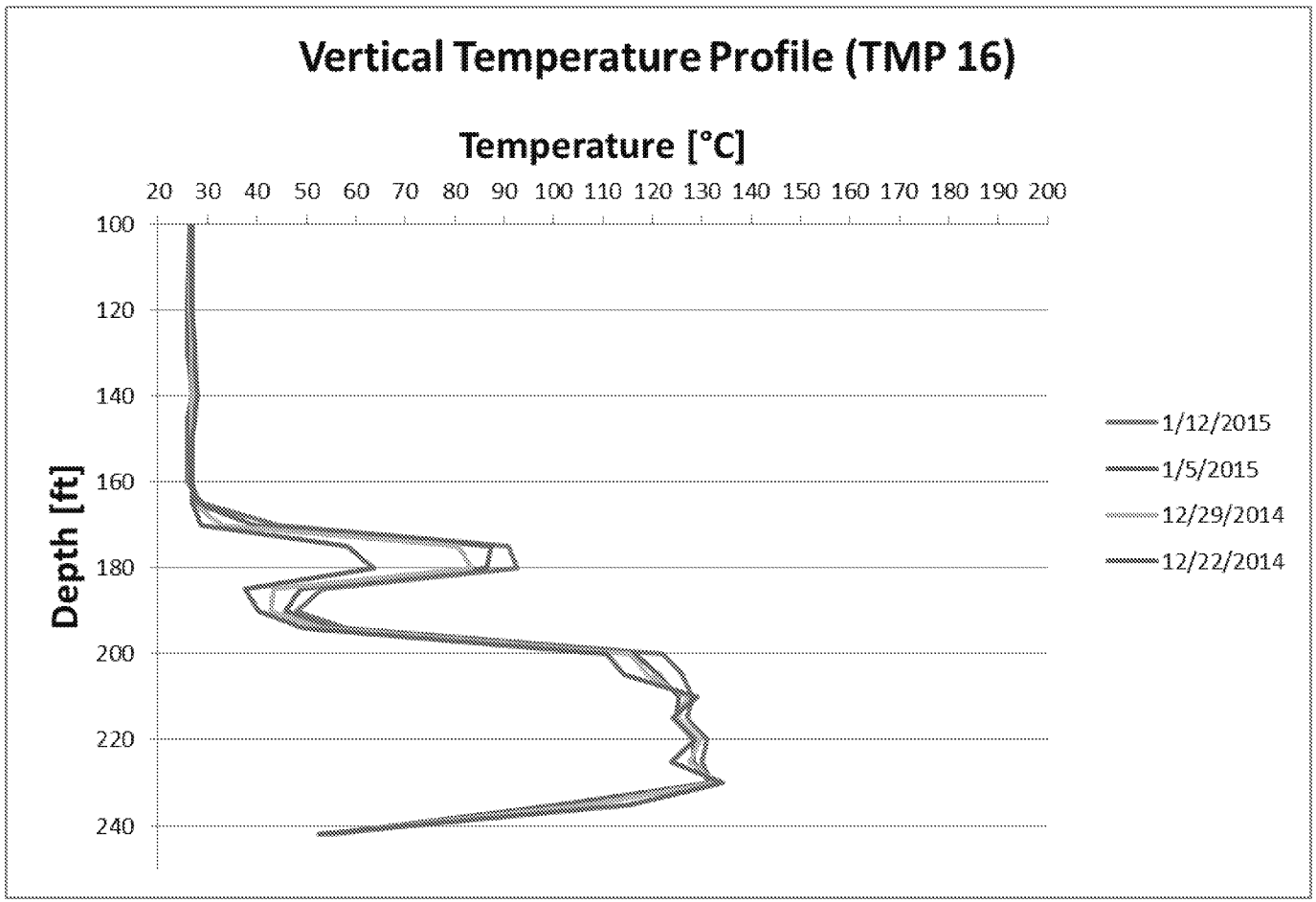

Vertical Temperature Profile (TMP 11)
Temperature [°C]
20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Depth [ft]
100 120 140 160 180 200 220 240
1/12/2015
1/5/2015
12/29/2014
12/22/2014


Vertical Temperature Profile (TMP 12)
Temperature [°C]
20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Depth [ft]
100 120 140 160 180 200 220 240
1/12/2015
1/5/2015
12/29/2014
12/22/2014


Vertical Temperature Profile (TMP 13)
Temperature [°C]
20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Depth [ft]
100 120 140 160 180 200 220 240
1/12/2015
1/5/2015
12/29/2014
12/22/2014


Vertical Temperature Profile (TMP 14)
Temperature [°C]
20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Depth [ft]
100
120
140
160
180
200
220
240
1/12/2015
1/5/2015
12/29/2014
12/22/2014


Vertical Temperature Profile (TMP 15)
Temperature [°C]
20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Depth [ft]
100 120 140 160 180 200 220 240
1/12/2015
1/5/2015
12/29/2014
12/22/2014


Vertical Temperature Profile (TMP 16)
Temperature [°C]
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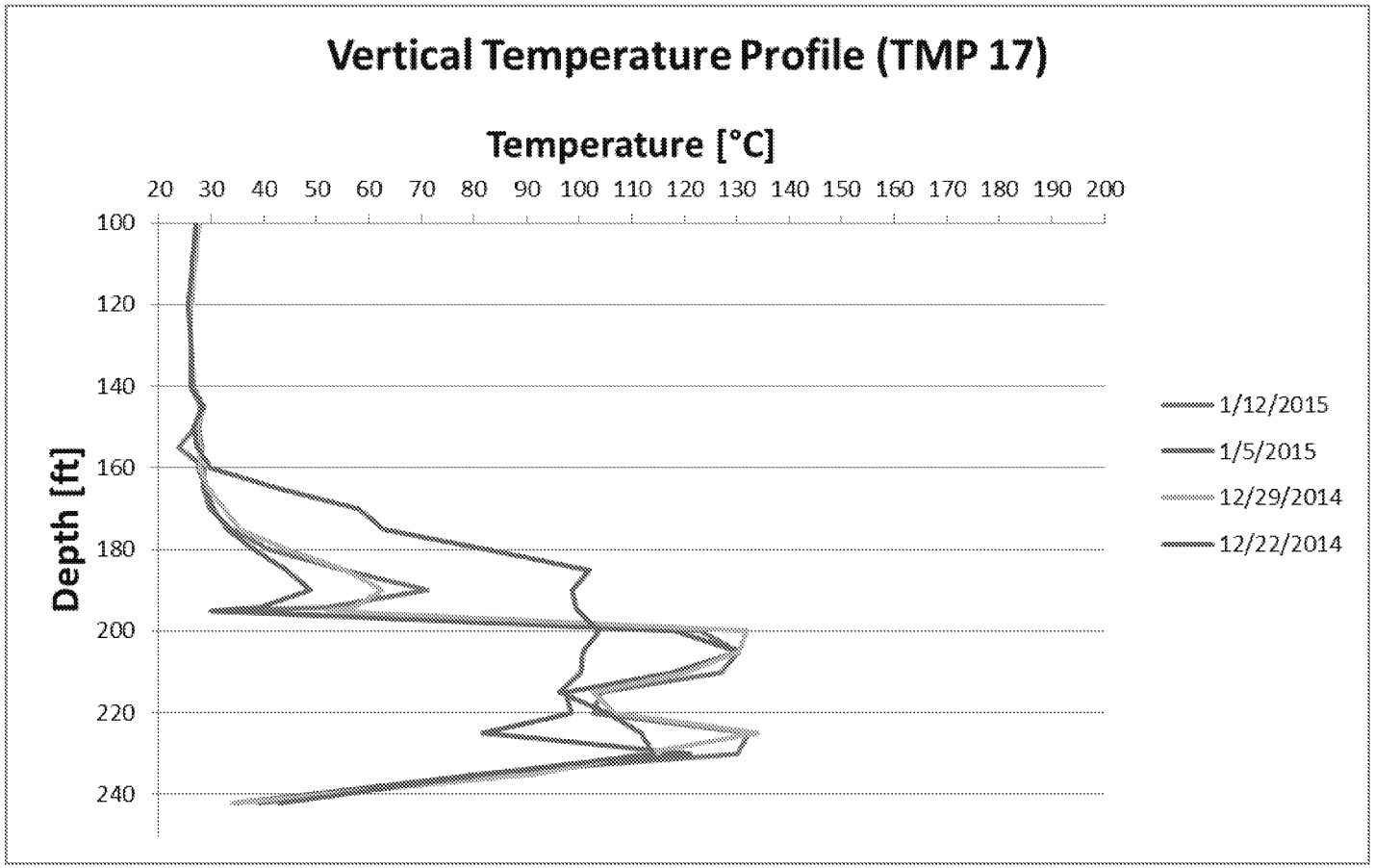
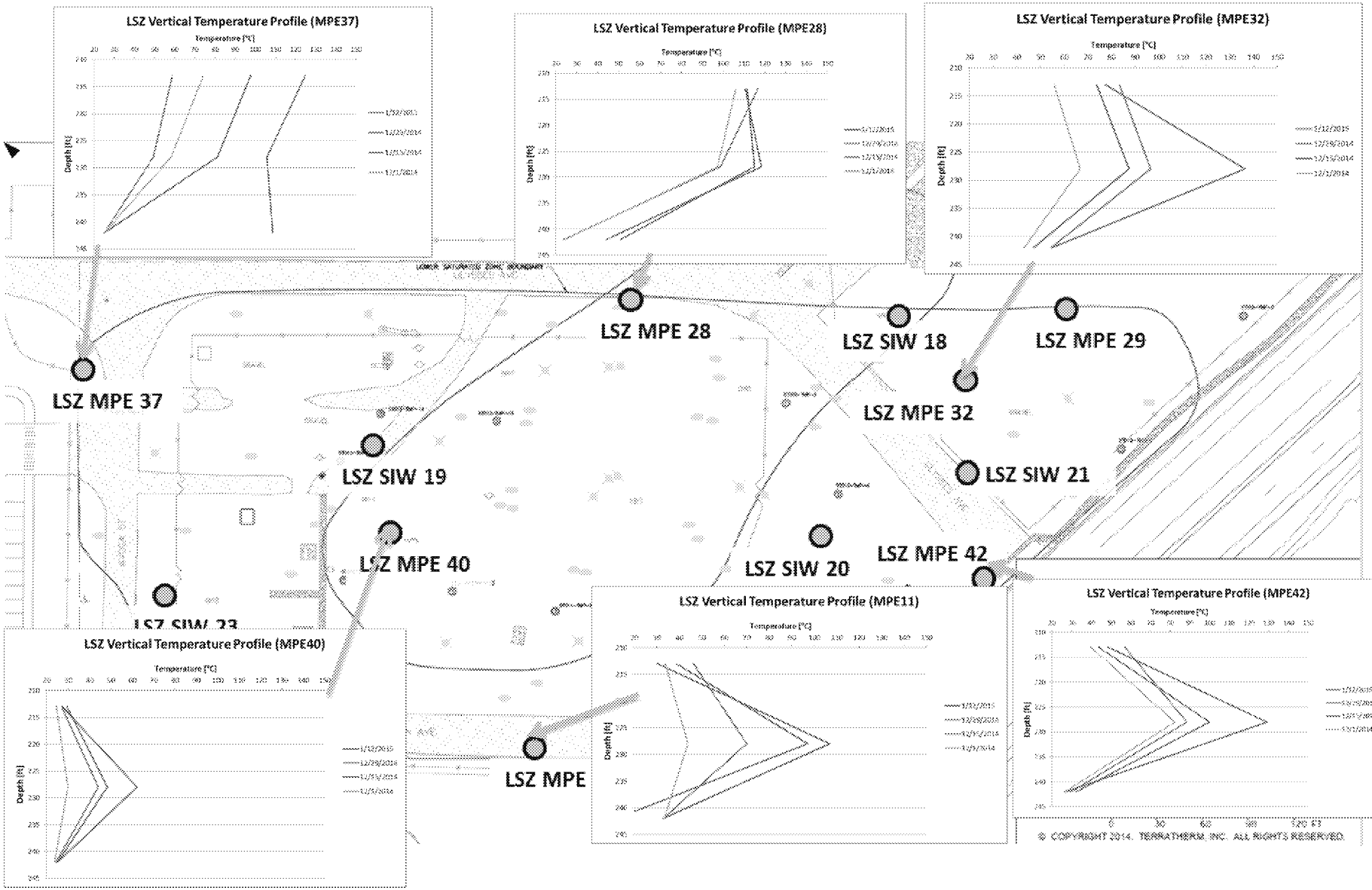
Depth [ft]
100
120
140
160
180
200
220
240
1/12/2015
1/5/2015
12/29/2014
12/22/2014


Vertical Temperature Profile (TMP 17)
Temperature [°C]
20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Depth [ft]
100 120 140 160 180 200 220 240
1/12/2015
1/5/2015
12/29/2014
12/22/2014

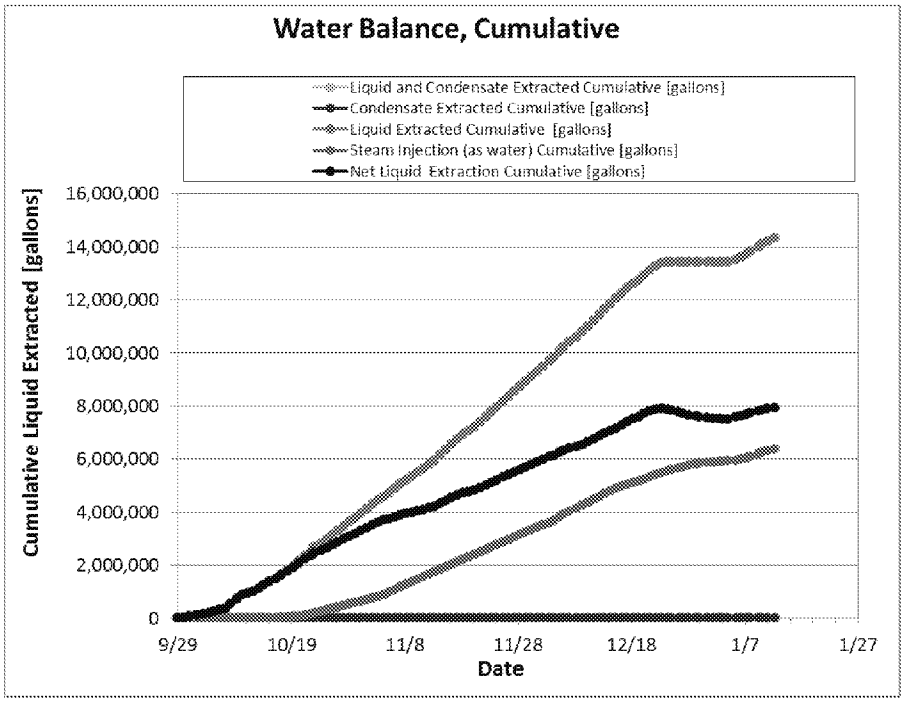
Subsurface Heat up Progression Measured at Collocated Extraction Well Thermocouples

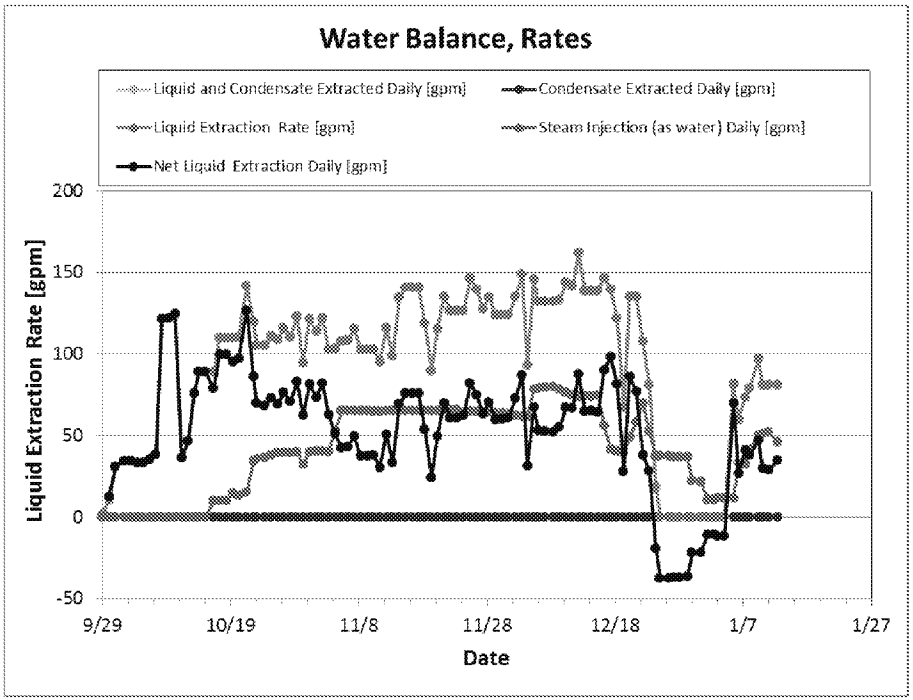
ST012 SEE COLLOCATED TEMPERATURES AT LSZ EXTRACTION WELLS: 12/1-1/12



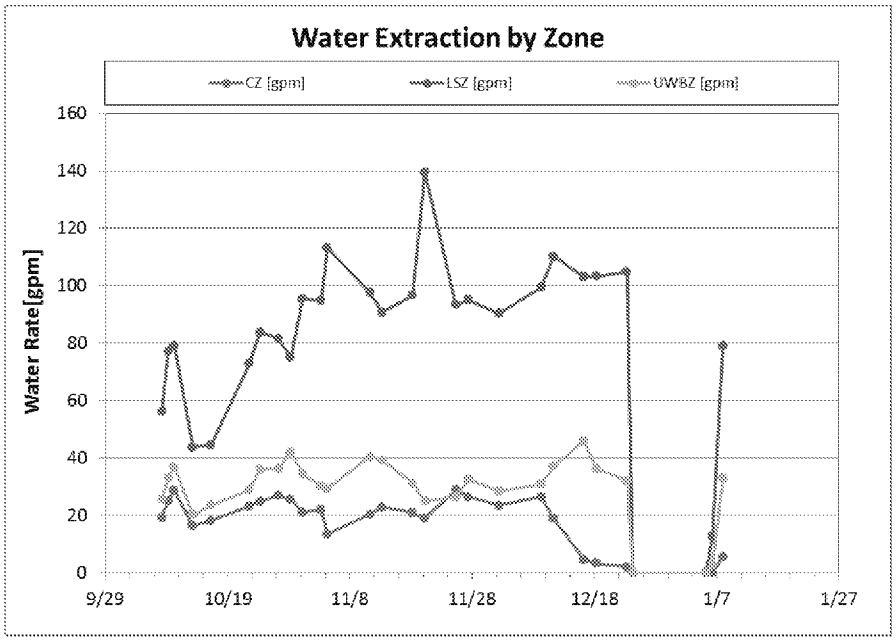
ST012 Injection/Extraction Balance Status

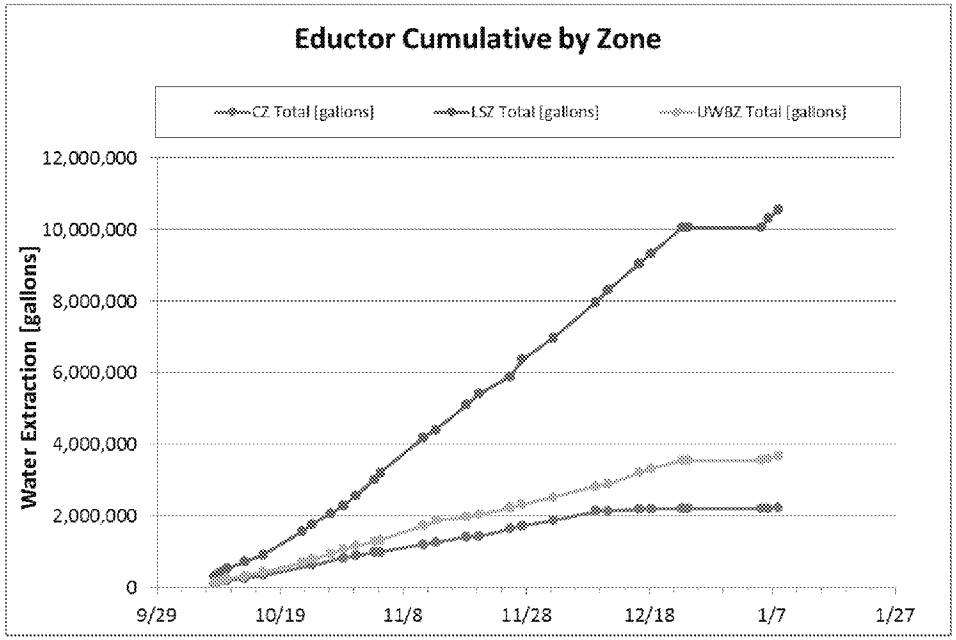
ST012 SEE SYSTEM WATER EXTRACTION BY ZONE





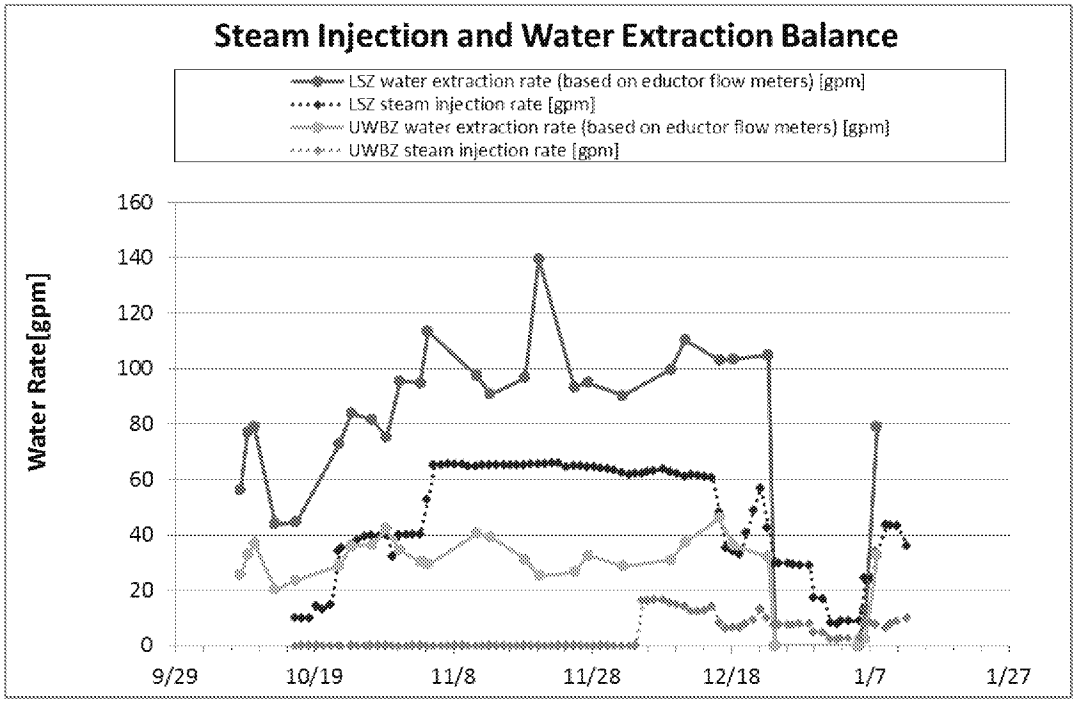
ST012 SEE SYSTEM WATER EXTRACTION BY ZONE





- **Eductor extraction rates per zone are based on individual eductor feed and return meters**

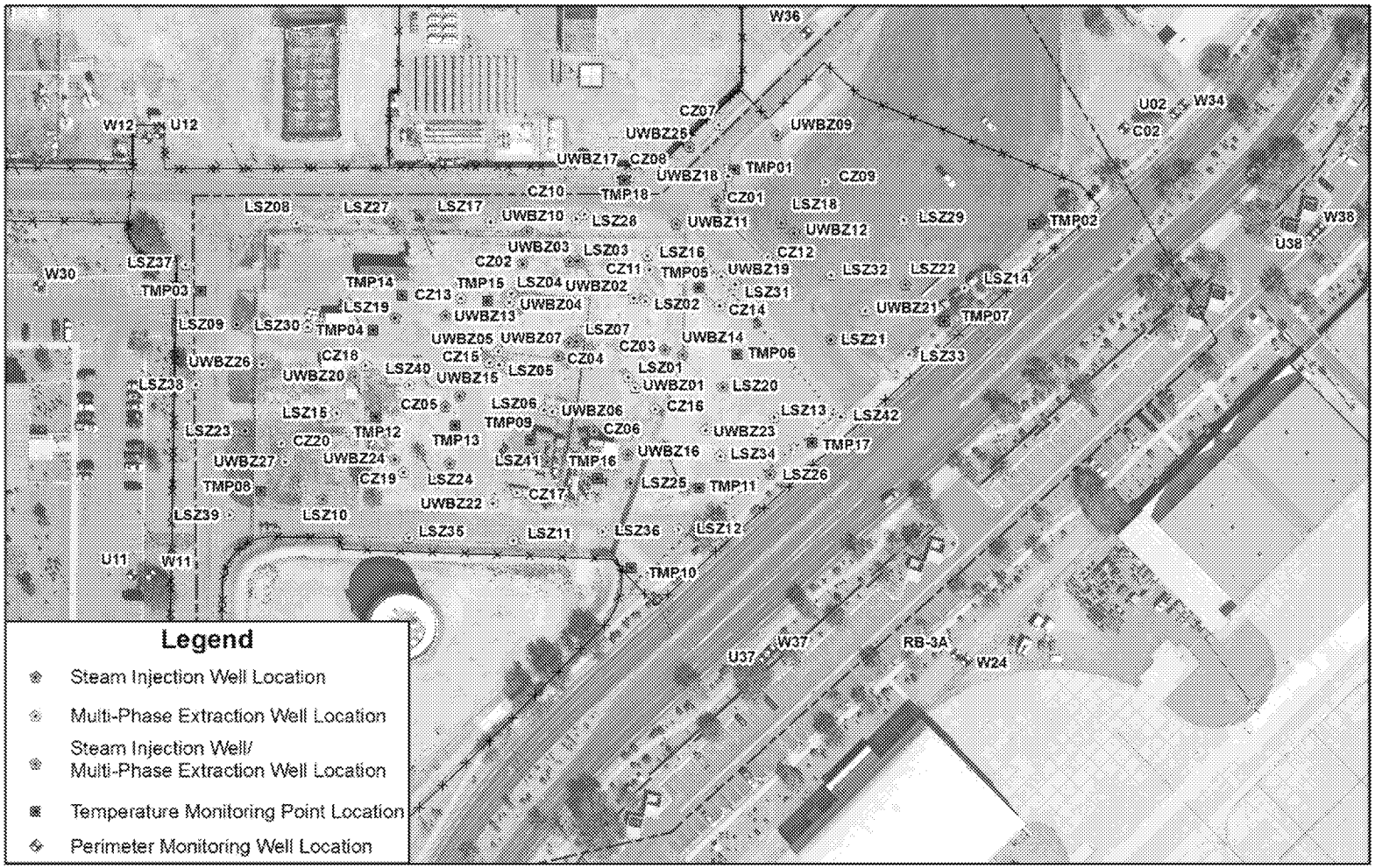
ST012 SEE SYSTEM INJECTION/EXTRACTION BALANCE



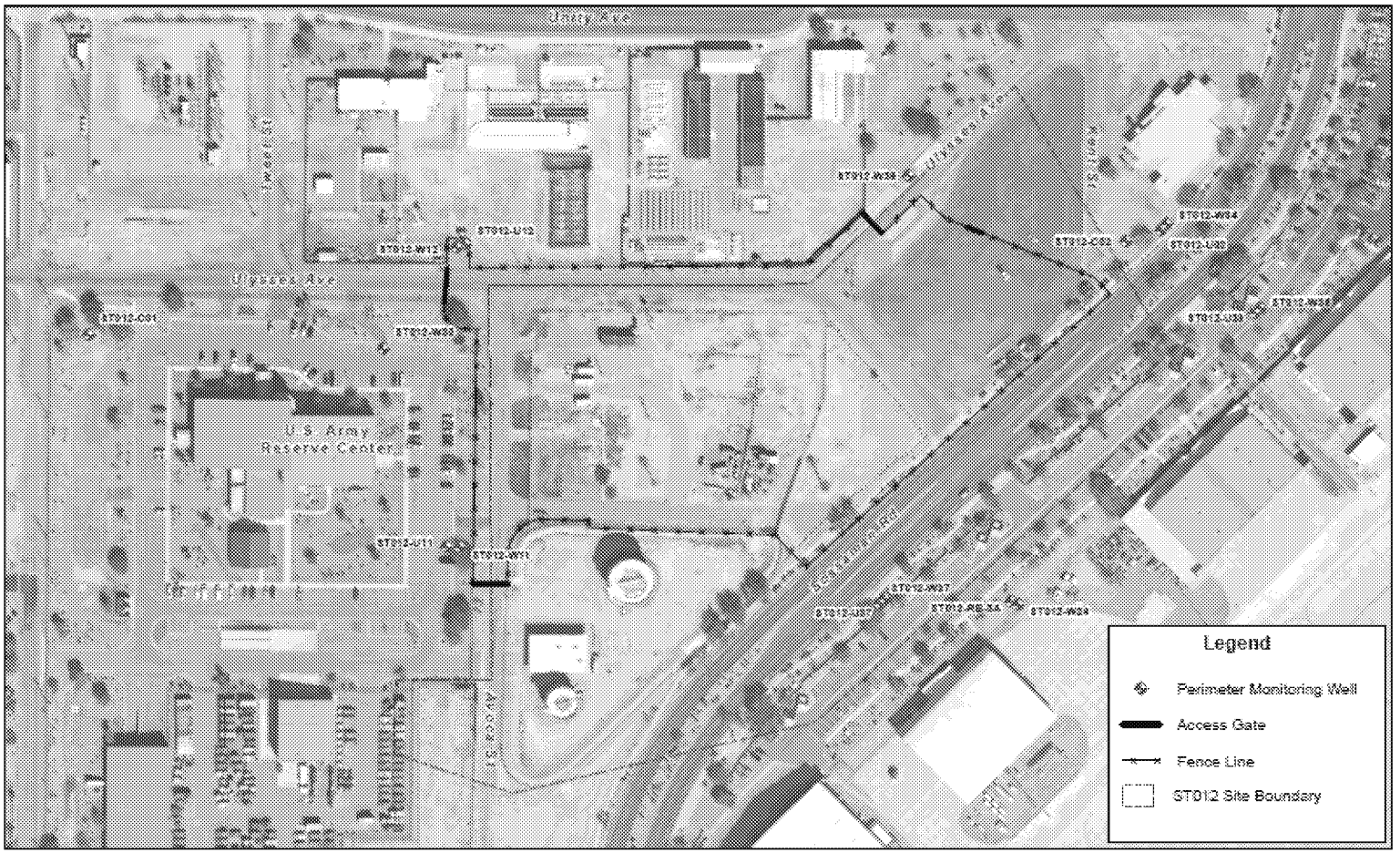
	CZ [gallons]	UWBZ [gallons]	LSZ [gallons]
Water extracted	2,221,000	3,680,000	10,555,000
Water injected (as steam)	0	513,000	5,900,000
Net extraction	2,221,000	3,167,000	4,655,000

- Note, water extracted to date per zone is based on eductor individual meters

ST012 SEE WELLS



ST012 SEE PERIMETER GROUNDWATER MONITORING WELLS



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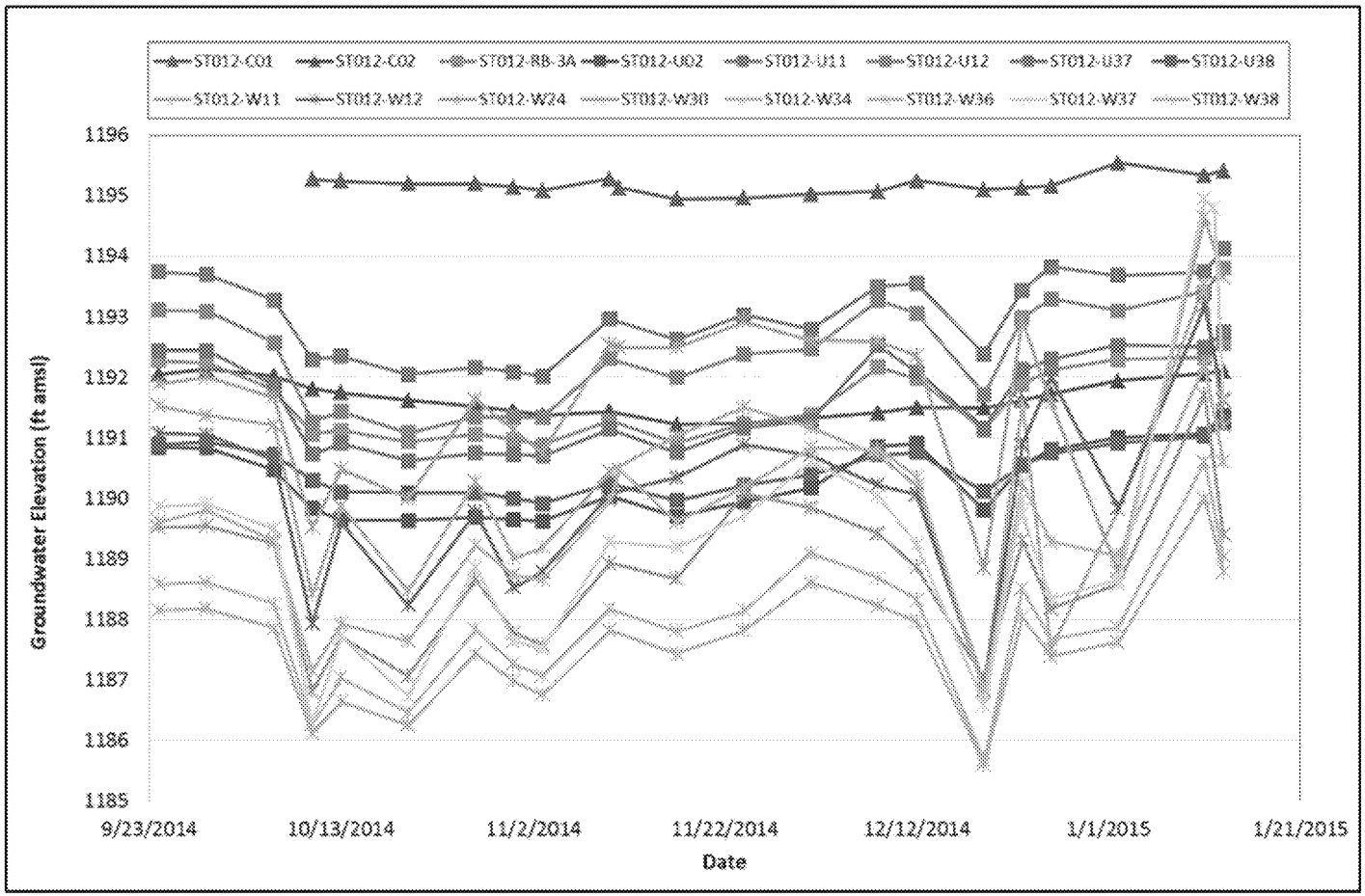
ST012 SEE PERIMETER GROUNDWATER LEVEL DATA

Monitoring Well	12/19/2014		12/23/2014		12/26/2014		1/2/2015		1/11/2015		1/13/2015	
	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous
CZ/UWBZ Wells												
ST012-C01	-0.52	0.15	-0.51	-0.03	-0.49	-0.03	-0.14	-0.38	-0.38	0.20	-0.32	-0.07
ST012-C02	-0.91	-0.01	-0.80	0.13	-0.71	0.10	-0.52	0.22	-0.44	0.12	-0.41	0.04
UWBZ Wells												
ST012-R8-3A	-1.49	-0.85	-0.76	0.75	-0.53	0.24	-0.39	0.17	-0.40	0.03	-0.18	0.23
ST012-U02	-1.39	-1.10	-0.66	0.75	-0.42	0.25	-0.25	0.20	-0.23	0.06	0.07	0.31
ST012-U11	-1.71	-1.17	-0.67	1.06	-0.30	0.38	-0.47	-0.14	-0.45	0.06	-0.08	0.38
ST012-U12	-1.75	-1.35	-0.50	1.27	-0.20	0.31	-0.42	-0.19	-0.15	0.31	0.24	0.40
ST012-U37	-1.63	-0.93	-0.69	0.96	-0.52	0.18	-0.32	0.23	-0.39	-0.03	-0.16	0.24
ST012-U38	-1.13	-0.65	-0.72	0.43	-0.53	0.20	-0.39	0.17	-0.32	0.11	-0.11	0.22
LSZ Wells												
ST012-W11	-4.95	-3.29	-0.31	4.66	-4.39	-4.07	-2.11	2.31	1.56	3.71	-0.79	-2.34
ST012-W12	-4.58	-3.22	-0.56	4.04	0.55	1.12	-1.64	-2.16	1.66	3.34	0.09	-1.56
ST012-W24	-2.86	-1.85	-0.59	2.29	-1.72	-1.12	-1.36	0.39	1.74	3.14	-0.59	-2.32
ST012-W30	-3.40	-3.52	0.69	4.11	-0.69	-1.37	-3.51	-2.79	2.30	5.85	1.32	-0.98
ST012-W34	-3.26	-2.65	-0.46	2.82	-1.30	-0.83	-1.12	0.21	1.57	2.73	0.00	-1.56
ST012-W36	-3.17	-3.56	0.26	3.45	-0.71	-0.96	-0.97	-0.23	2.13	3.14	0.53	-1.59
ST012-W37	-3.63	-2.66	-0.24	3.40	-0.50	-0.25	-1.93	-1.39	-1.65	0.32	1.36	-3.28
ST012-W38	-2.91	-2.37	-0.48	2.45	-1.15	-0.66	-0.94	0.24	1.40	2.38	0.17	-1.22

ST012 SEE PERIMETER GROUNDWATER ELEVATIONS



- **Water level increases are temporary**

ST012 SEE REVISED OPERATIONAL STRATEGY

- Maintain a total wellfield extraction rate of ~300 gpm (both extracted wellfield water and eductor return water)
- Keep (2) down gradient wells running for hydraulic containment (CZ14 and CZ16)
- Continue with reduced steam injection rates in the UWBZ and LSZ
- Steam injection in CZ on standby for now
- Next week begin the addition of Verox 8 (microbiocide) to the eductor loop

ST012 SEE OPERATIONAL PLAN – UPDATE

Operational Plan through February

- **Continue operating the current wells until 3 MPE wells are serviced (Mid January)**
  - 9 out of 15 exterior and interior LSZ steam wells are operating
  - 4 out of 7 exterior UWBZ steam wells are operating
  - Operating at approximately 90 gpm liquid extraction and 60 gpm steam injection (30,000 lbs/hr)
  - Steam wells within approximately 100 ft of a well to be serviced are idling at approximately 15-20% input
  - Looking into treatment capacity for the treatment system – planning to begin the Verox 8 pilot test
- **Complete modified step 3 , when all MPE wells are back online (End of January)**
  - 15 exterior and interior LSZ wells are operating
  - 7 exterior UWBZ wells are operating
  - No CZ wells operating
  - Operating at about 90 gpm liquid extraction and 60 gpm steam injection (30,000 lbs/hr) with same net flow
  - Balancing the flows to maintain an acceptable water balance
- **Modified steam injection step 4 (interior UWBZ) (February)**
  - Same 15 exterior and interior LSZ wells from Steps 1 and 2
  - Same exterior UWBZ wells as Step 3
  - Add interior UWBZ wells
  - Injection rates will continue to be balanced across the wellfield to maintain an acceptable water balance

ST012 SEE OPERATIONAL CHALLENGES

- Iron Fouling
- Bio Fouling/NAPL Emulsion – Liquid Treatment System Residence Time
- Eductor Pump Pulling and Replacement
- Perimeter Water Levels
- Temperature Monitoring Point Thermocouples